THE BRITISH MUSEUM (NATURAL HISTORY) EXPEDITION TO EAST NEPAL 1961-62

INTRODUCTION AND LISTS OF LOCALITIES

BY

J. G. SHEALS AND WILLIAM G. INGLIS

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INTRODUCTION

As a complex transitional zone the Himalayan region is of outstanding biogeographical interest. Extending for 1,500 miles from Upper Burma in the East to Afghanistan in the West, this system of Tertiary mountains forms an almost unbroken chain between the Indo-Gangetic Plain and the high plateaux of Central Asia. Zoogeographically the elevation is responsible for a remarkable southerly extension of the Palaearctic zone resulting in a peculiar confluence of Indian, Indo-Malayan, Mediterranean and Northern Palaearctic elements, while floristically the range forms a unique corridor between tropical India and arid Central Asia enabling plants of the temperate Sino-Japanese region to migrate westwards to the border of the African-Indian desert.

A detailed geographical account is given by Burrard & Hayden (1907). The system is not a single mountain chain but a complex series of nearly parallel ranges separated by valleys and high plateaux. Three longitudinal groups can be readily recognised. The Great Himalaya, an inner range on which lie the highest peaks; the Lesser Himalaya, a series of ranges rising to approximately 15,000 ft. and an outer system of foothills, the Siwaliks, contiguous to the Tarai forest and the plains of India. Although their upheaval was probably accompanied by a further elevation of the inner ranges, the Siwaliks are more recently formed and, in many places, a unique system of longitudinal valleys or Duns is found between these foothills and the intermediate ranges. The Himalayas can also be conveniently divided into four East-West sections and of these the least known yet possibly the most interesting biologically is the Central or Nepal Himalaya. This section, approximately 500 miles in length lies almost entirely within the present political boundaries of Nepal but geographically is defined as that portion of the system lying between the Tista and Kali rivers. The major peaks include Kanchenjunga, Everest, Makalu and Dhaulagiri and the general trend of the Great range in this section is from East to North of West except near the eastern extremity where the long Singalila ridge extends abruptly Southwards to the plains from the Kanchenjunga massif. Each section of the Himalayas has certain characteristic features. In Nepal the dun valleys are well marked and there is a tendency for the great peaks to stand in clusters or rows, each aggregation being known to the Nepalese as a Himal, e.g. Langtang Himal and Jal Jale Himal. The five principal rivers of the Nepal Himalaya are the Karnali, Rapti, Bagmati, Gandak and the Kosi, all affluents of the Ganges. The Karnali and Rapti systems drain the western area between the Garhwal border and Dhaulagiri, and the great basin of the Gandak occupies the central zone between the Annapurna and Langtang Himals. The Bagmati rises in the lesser ranges and

drains the Central Nepal Valley, while the Kosi, one of the most important of all the Himalayan rivers, drains the region east of Gosainthan. Its principal tributary, the Arun, cuts an impressive gorge through the Great Range a few miles East of Mount Everest, and its most easterly affluent, the Tamur, drains the South-western face of Kanchenjunga and the Western slopes of the Singalila ridge.

PREVIOUS BIOLOGICAL EXPLORATION

The isolationist policy adopted by Nepal until 1947 was so rigidly enforced that Landon (1928) was able to present a list of all the Europeans who had visited the country during the period 1881–1925. During these 45 years about 153 persons visited Nepal for military, official and antiquarian purposes and 55 as guests of the Maharaja. Although there was no general prohibition against Asiatics, with one notable exception even the most privileged Europeans were forbidden to travel outside the Tarai or, in upland Nepal, more than a few miles beyond the narrow limits of the Kathmandu Valley. Despite these restrictions, however, significant biological contributions were made during the 19th century.

The early botanical work, culminating in the publication of Don's *Prodromus Florae Nepalensis* (1825) and Wallich's *Tentamen Florae Napalensis* (1824–26), began with the visit of Francis Buchanan (later Hamilton), botanist and physician, to Kathmandu in March 1803. Buchanan stayed in the Valley for about a year and later (1807–1814) directed a great botanical survey of north and west Bengal, detaching Asiatic members of his staff to collect economic plants from the Nepal Himalaya (Prain, 1905, Burkill, 1953). Shortly after the appointment in 1816 of Edward Gardner as first political Resident at Kathmandu, Nathanial Wallich, then in charge of the East India Company's Botanic Garden at Calcutta, sent two collectors to work under the Resident's direction. They appear to be those who sent the first seed of *Rhododendron arboreum* to England in 1818 (Burkill op. cit.). Wallich himself spent the year 1821 in Kathmandu but like Buchanan was hampered by restrictions on his movements although his collectors penetrated deep into the mountains along the pilgrims' road to Gosainkund. David Don, who curated the private collections of Aylmer Bourke Lambert, based his *Prodromus* on Buchanan's Kathmandu material, part of this collection having been presented to Lambert in 1806, but he also studied Nepalese plants sent to Lambert by Wallich. A substantial part of Lambert's herbarium, including the Buchanan collection, was purchased by the British Museum in 1842.

A number of mosses collected by Gardner, Buchanan and Wallich are described in W. J. Hooker's *Musci Exotici* (1818, 1820). Gardner & Wallich also presented a number of birds, mammals and many insects from Nepal to Major General Thomas Hardwick. Some of these Hardwick described, others he presented to the British Museum and to the Zoological and Linnean Societies. Hardwick returned to England in 1823 and assisted Gray (1830–35) with the first volumes of the projected *Illustrations of the Indian Fauna* (Kinnear 1925, Sawyer 1953).

Brian Houghton Hodgson was Assistant Resident, and later Resident, at Kathmandu during the period 1820–1843. Diplomat, oriental scholar and

antiquarian, he has been described as one of the greatest and least thanked of all our British Residents and one of the greatest labourers in the sphere of Indian research and record (Hunter 1896, Landon 1928). His contributions to zoology were no less distinguished. He early appreciated the zoogeographical significance of the Himalayas and recognised a faunal zonation associated with altitudinal differences. During his service at Kathmandu he laid down the foundations of Himalayan mammalogy in upwards of 70 scientific papers. His interests also extended to ornithology and it is probably in this field that his greatest zoological contributions were made. After leaving Kathmandu he continued his researches in retirement at Darjeeling, returning to England in 1858. The most important part of his collections of specimens and drawings was presented to the British Museum (Gray 1863) and the smaller part originally presented to the East India Company's Museum was merged with the main collection in 1881. Hodgson's many zoological papers are catalogued by Hunter (1896) and amongst the early reports on his fish and reptile collections are those of Cantor (1839) and Gunther (1860, 1861, 1864).

Sir Joseph Hooker's remarkable exploration of East Nepal is described in his famous *Himalayan Journals* first published in 1854. It is surprising that this visit to Nepal was sanctioned but some light is thrown on the circumstances by Hooker's recollections in Hunter's *Life* " I owe it entirely to his (Hodgson's) personal influence with the late Sir Jang Bahadur that I was permitted to travel in Eastern Nepal over ground never before or since traversed by any European and to visit the jealously guarded passes of the Nepalese Tibet frontier ". Hooker left Hodgson's house at Darjeeling on 27th October 1848 and with a party of 56, including a guard of 6 Nepalese soldiers and 2 officers and " Mr. Hodgson's bird and animal shooter, collector and stuffer ", crossed the Singalila ridge near Tanglu on 5th November : Hooker's route in Nepal can be fairly easily traced, although problems of transliteration render the identity of a few localities problematical. Crossing the " Sakkiazung ridge " (Mahabharata Lekh) near Malinge he descended to the Hima Khola which he followed to its junction with the Tamur. He then made his way up the valley to Walungchung Gola passing through " Mywa Guola ", which, from his description must certainly be the trading village now called Dobhan (sometimes spelt Dumuhan). After exploring the region of the " Wallanchoon Pass " i.e. Tiptala Bhanjyang (16,740 ft.) he followed the Yangma Khola to Yangma Village and thence to the Tibetan frontier again at Khangla Deorali (18,315 ft.). Traversing the high ridge South of Yangma he then explored the Ghunsa Khola as far as " Kambachen " (Khamachin). On 5th December he began his southward trek, and crossing the Simbua Khola near Chairam, passed through " Tchonboong " (? Phungphung) and Sablakhu. Finally he followed the upper reaches of the Kabeli and on 15th December recrossed the Singalila a few miles North of Phalut. After exploring Sikkim and Assam, Hooker returned to Britain in 1851 and in conjunction with Thomas Thompson produced the first volume of the projected *Flora Indica* (1855) but the series was subsequently abandoned owing to lack of financial support. Much of Hooker's bryophyte material is described by Mitten (1859, 1860).

During the remainder of the 19th century almost the only contributions were

those made by the members of the Residency Staff, although a collector of the Indian Museum appears to have visited Kathmandu in 1871. In the preface to his *Lepidoptera Indica* Moore (1890) acknowledges the collection of numerous specimens of moths from Nepal made by Major General G. Ramsay, Resident during the period 1852–67, while the Residency Surgeon from 1876–1878, John Scully, published on birds (1879) and later on the Chiroptera (1887). During the latter part of the 19th century several major compilations on the flora and fauna of the Indian sub-continent appeared (e.g. Hooker's *Flora of British India*, 1872–1897 and the first monographs of the *Fauna of British India*) but in relation to the Nepalese species these were substantially dependent on the collections made before 1850.

Boulenger, Annandale, Wall & Regan (1907) reported on a collection of fish, amphibia and reptiles made in the vicinity of Kathmandu in 1906 by R. Hodgart, a collector of the Indian Museum, while I. H. Burkill, a botanist, also of the Indian Museum, visited Kathmandu at the end of 1907. In his notes on the journey Burkill (1910) includes a list of plants and gives an account of the cultivation and zonation of vegetation in the Valley and on the route between Raxaul and Kathmandu.

In 1912 the Bombay Natural History Society initiated the Mammal Survey of India with the primary object of obtaining topotypes for systematic studies and to investigate the variation and distribution of the fauna in the sub-continent. Collections in Nepal were made during August 1920–March 1921 by the British Envoy, Lt. Col. R. L. Kennion, with the assistance of the Society's collector N. A. Baptista. The localities covered were the Tarai, the Duns (Rapti Valley), the Kathmandu Valley and the basin of the Gandak up to 50 miles North of Kathmandu. A scientific report on this collection was made by Hinton & Fry (1923). A further collection in the districts west of Kathmandu was made by Baptista during the year May 1922–May 1923 and a supplementary report was written by Fry (1925). Collections of birds made during this time by Kennion and Baptista were of value in confirming the status and distribution of a large number of species (Prater 1928).

Hay (1934) observes that the serious botanical exploration of Nepal did not commence until 1928 when the Prime Minister, Maharaja Chandra Sham Sher, appointed Major Lall Dhwoj to collect seeds and specimens. Dhwoj collaborated with the Forest Research Station, Dehra Dun, in a brief exploration of S.W. Nepal in the Spring of 1929 (Parker 1932) and subsequently collected in Central and East Nepal. Many hundred sheets of specimens were received by the British Museum (Natural History) and to him is credited the introduction of several fine plants including *Gentiana ornata*. Dhwoj died in 1931 and was succeeded by Professor K. Sharma who made extensive and valuable collections during the period 1931–1937. Valuable plant collections were also received at this time from Lt. Col. F. M. Bailey, Envoy at Kathmandu during the period 1935–38. An eminent Lepidopterist, Bailey made collections in the Tarai and in the Valley, while the Nepalese workers whom he trained brought in botanical and zoological material from West Nepal and from the country North of Kathmandu (Bailey 1951).

Zoological exploration after the second world war appears to have been initiated by S. Dillon Ripley, an ornithologist who visited the Valley in April and May 1947. Later that year another ornithologist, B. E. Smythies, received permission to make a fortnight's tour of the pilgrim trail to Gosainkund with the stipulation that he did not go within 5–6 miles of the Sacred lakes (Smythies 1948). This almost unprecedented concession foreshadowed a more liberal attitude by the Nepalese Authorities and, apart from certain minor restrictions, after the beginning of 1948 the barriers to foreign exploration were gradually removed. As a result, since 1949 a large number of expeditions have visited Nepal. The majority of these have been primarily mountaineering, although many have had secondary biological objectives, for example Tilman's expedition to the Langtang and Annapurna Himals (Tilman, 1952) and the Californian Himalayan Expedition to Makalu (Houston & Long, 1955 ; Leviton, Myers & Swan, 1956). The British Museum (Natural History) and Royal Horticultural Society jointly sponsored expeditions to West Nepal in 1952 and 1954 (Williams, 1953 ; Sykes, 1956). These expeditions were mainly concerned with flowering plants although both made small but valuable entomological and other zoological collections. Additionally, biological studies in the Nepal Valley have been continued by Mrs. D. Proud (1949, 1952, 1955) and by Herklots (1962).

THE 1961–62 EXPEDITION

The project was planned with a view to obtaining botanical, entomological and other zoological material from the Eastern part of the Nepal Himalaya, a comparatively little-known area but potentially interesting by virtue of its position along the confluence of distinctive biogeographical zones. The greater part of the work was carried out in the Dhankuta province between the Arun River in the West and the Kanchenjunga Massif and the associated Singalila Range in the East. The botanical programme was directed mainly towards the Cryptogamic flora, particularly the Bryophyta, while the primary concern of the zoologists was an investigation of the Micro-arthropoda and Nematoda of soil, forest litter and allied habitats.

As the collection of phanerogamous plants was not a major objective the choice of season for the field work was less restricted. Although greater populations of insects might be expected during the main flowering season from April to August a great part of this season coincides with the monsoon period when travel in the hills is difficult and hazardous owing to swollen torrents. Moreover, during these months the high humidities might severely limit the efficiency of the desiccation funnels used for collecting micro-arthropoda. Consequently the field work was planned to begin at the end of the monsoon and the collections were actually made between 17th September 1961 and 20th March 1962. However, there was still a certain conflict of requirements. The botanist, and to a certain extent the entomologist, sought a wide cover of the area under investigation and their collecting techniques did not preclude continuous movement, but the zoologists required a permanent shelter to house their bulky apparatus. Also the zoologists' interests were centred largely around the forests of Rhododendron and Evergreen Oaks at altitudes where

Sketch map of East Nepal : scale 16 miles to the inch (approx.).

the population of winged insects would almost certainly be low after mid November. To meet these varied requirements it was planned to acquire some type of building at an altitude of about 5,000 ft. in the Taplejung region, and to use this as the nucleus of a base camp from which excursions could be made to all parts of the Eastern region.

There are two practical routes from India to the Taplejung area. The eastern route leads from Darjeeling over the Singalila at Sandakphu or Phalut and thence by way of Memeng and Anbung to the middle reaches of the Tamur. The southern approach is from Jogbani, Bihar State, via Dharan Bazar and Dhankuta. For a small party with a moderate amount of equipment the Darjeeling route is certainly preferable, for mechanical transport can be used as far as the crest of the Singalila and from this point the 5–6-day march is not severe, but for a large party with bulky stores the road and rail transport problems are less complicated on the southern route. Early in the planning stage the Commanding Officer of the H.Q. British Gurkha Lines of Communication at Dharan offered his full co-operation and it was resolved to use Dharan as an initial base where porters could be recruited and the bulked stores split into man-loads.

The stores and equipment, weighing approximately $3\frac{1}{2}$ tons, were taken by sea to Bombay and thence by rail, via Calcutta, to Jogbani and the final 30 mile road trip to Dharan was made in trucks belonging to the Brigade of Gurkhas. The Expedition left Dharan for the hills with 119 porters on 17th September 1961.

The success of the plan hinged largely on securing the use of a permanent building and a small reconnaissance party was fortunate in finding a suitable rest house or Dharam Sala at Sanghu, a small village at an altitude of about 6,000 ft. on the slopes of the Maewa Khola Valley. The village elders were co-operative and an added attraction was a level grass plot immediately in front of the Dharam Sala which would accommodate a large base camp. Sanghu was very near the geographical centre of the Dhankuta province and although the land in the immediate vicinity of the village was intensely cultivated, extensive forests of Evergreen Oak and Rhododendron could be reached within about two to four hours. The main party arrived at Sanghu on 26th September and the porters were paid off the following morning.

The ground floor of the Dharam Sala was equipped as a kitchen and the first floor as a laboratory-cum-messroom ; tables, shelves, and racks for the soil extraction apparatus being cheaply made in bamboo. The attic space provided additional storage for canned foods and equipment. Water supplies at Sanghu were always adequate but initially some difficulty was experienced in securing food supplies for the permanent staff of field assistants. This problem was solved by the energetic efforts of the Sirdar and after the October harvest supplies were always adequate. Kerosene for lighting and cooking was always available but rather expensive at about 8/– per gallon. Communication with Dharan, mainly for the purpose of sending and receiving mail, was maintained by runner. During the whole time of the Expedition Sanghu base was manned by some British members of the Expedition except during the period 4th–31st December, and during the last 2 weeks of January

when subsidiary bases for the exploration of the Arun and Tamur Valleys were set up at Tumlingtar and Dobhan respectively. Health problems were few, blood-sucking insects did not constitute a problem even at low altitudes but leeches were troublesome until the end of the monsoon and were common up to altitudes of 12,000 ft. It was found that leeches detached themselves immediately when given a short spray with a piperonyl butoxide/pyrethrum aerosol preparation.

Sanghu (27° 21′ N, 87° 33′ E) is at about 6,000 ft. on the south side of one of the terminal branches of the Maewa Khola near the Western end of the main valley system. The river runs West to East and rises on the slopes of a North-South-running ridge, the Milke Danra, which is about 11–12,000 ft. high in this area. The valley is steep-sided and narrow so that the village is somewhat enclosed by high ground particularly to the South and West. Sanghu, not marked on some maps, lies east of Tamrang and west of Tembe. It is not a compact group of houses and the name applies to the south side of the valley between two major streams. The Dharam Sala, which was used by the Expedition, and the school building lie on one of the very few flat areas of ground, just beside the main East-West track running from Taplejung in the East to Chainpur in the West crossing the ridge by a pass—the Milke Bhanjyang—at about 11,000 ft. The entire valley side is carved into small paddy fields, up to about 7,500 ft., and is very densely cultivated. On the high ridges behind the camp is a belt of Evergreen Oak forest from 7,500 ft.–9,300 ft. and above this, Rhododendron forest extends about to the top of the ridge which is bare of large bushes or trees. The area produces large quantities of oranges (Santala), which—with bananas—grow up to about 6,000 ft. The main food crop is rice, with some potatoes and other vegetables of minor importance. Domestic animals are cattle, water-buffalo, sheep, pigs and hens. Because of the intensity of the farming the only uncultivated land below 7,500 ft. tended to be in the gullies and on very steep slopes, although the walls of the paddy fields afforded a minor habitat of some interest.

The river to the west of Sanghu (between Sanghu and Tamrang) passes, at one point, through a narrow gorge bounded by steep cliffs about 200 ft. high. The flat area of sandy soil at the bottom of the gorge, bordered on the west by the river and the east by a steep bank covered by mixed vegetation, afforded an isolated natural area unaffected by cultivation.

Dobhan (27° 22′ N, 87° 37′ E) lies at the junction of the Maewa Khola and Tamur River about half-a-day's march East of Sanghu at an altitude of about 2,500 ft. It is a major trading centre with a number of permanent shops. There is a small, flat plateau lying North–South in the junction of the two rivers both of which are crossed by chain bridges. The soil is very light and sandy with a certain amount of mica.

Tumlingtar (27° 18′ N, 87° 13′ E) is an extensive flat plateau lying at about 1,800 ft. between the Arun River and the Sabhaya Khola at their junction. The plateau is bounded by steep cliffs, about 150–200 ft. high and is extremely dry with only very few pools of stagnant water so that most water for use on it must be carried up from the rivers. The soil on the plateau and the surrounding areas is poor, sandy, and red

in colour with a high mica content. The edges of the plateau and the steep hills bordering the valley systems are marked by deep and extensive erosion gullies. The cliffs on the west side, bordering the Arun River are very steep while those on the east are less vertical with a fairly extensive flood plain between their bottom and the Sabhaya Khola. As at Sanghu and Dobhan every available piece of land is cultivated. The most obvious feature of the entire area was this extensive cultivation. Virtually every scrap of land which could be used for crops was used with a great reduction and, in some localities, elimination of any natural habitat.

BOTANY

Over 5,000 botanical specimens were collected. Special attention was paid to bryophytes and lichens and together these constituted over 75% of the material collected. About 300 phanerogams and a similar number of pteridophytes were also dried. The conditions in the main areas investigated were much more moist than had been expected and the profusion of bryophytes generally was extremely gratifying. In particular the rich hepatic flora in the immediate vicinity of Sanghu base provided scope for intensive study. The rocks and shaded stream banks in gullies bore a profusion of bryophytes and bamboo thickets in these gullies harboured many unusual mosses of the family Sematophyllaceae. Small bryophyte species were plentiful on north-facing walls of rice terraces and were also abundant on the trunks of trees and on moist ground in the Evergreen Oak forests at about 7,500–9,000ft. Above this altitude, in the Rhododendron forests, foliaceous lichens, particularly *Anaptychia* and *Usnea* species, were common. The dry Tumlingtar plateau, which was visited in December, provided a sharp contrast with the Sanghu area. Here hepatics were uncommon but in shaded habitats mosses were plentiful although limited to a few species. The steep cliffs above the Sabhaya and Arun Kholas supported a remarkable flora of crustaceous lichens. On the open cliffs there were also patches of xerophytic *Selaginella* and in the less exposed areas colonies of *Fissidens* species were not uncommon.

A camp was made for a few days in the Mewa Khola gorge above Dongen. In this remote and unspoiled area the dense forests (predominantly oak) were extremely rich localities and would have provided scope for several weeks' collecting. Unfortunately inclement weather made a longer stay impossible. Of particular interest was the profuse flora of smaller mosses and hepatics carried by the branches of shrubs. Amongst the hepatics the smaller Lejeuniaceae were prominent on the bare parts of twigs and stems and also on fern fronds. *Daltonia* species were also common and this was the only locality where species of *Distichophyllum* were found.

In February a short visit was paid to the Tarai forest immediately south of Dharan. A few mosses were collected but at this time conditions were much drier than in the hill forests and Cryptogams were not abundant.

LOCALITIES

SANGHU BASE CAMP AREA. 27° 21′ N., 87° 33′ E. Alt. 5,500–7,000 ft. 2.x.61–4.xii.61, 1.i.62–16.i.62, 11.ii.62–19.ii.62.

Numerous habitats in immediate vicinity of camp site, including walls, rocks, banks of streams and tracks, shallow gullies, stems of shrubs, decaying wood, tree stumps and bamboo grooves.
Ficus religiosa : roots, trunks and upper branches.
Rice terraces : standing crops, stubble and terrace walls.
Small wood immediately above camp.
Small ravine by Tamrang track : rocks and scrub by river.
Gully torrents by Tembe track : banks, rocks, bamboo groves and overhanging trees.
Castanopsis forest : on and amongst trees and in clearings.
Scrubland above *Castanopsis* forest : various habitats including shallow ravines.

SANGHU OAK FOREST AREA. 27° 19′ N., 87° 32′ E. Alt. 7,800–9,300 ft. 2.x.61, 5.xi.61, 28.xi.61, 29.xi.61, 1.xii.61.
Forest, mainly *Quercus lamellosa* and *Q. lineata :* forest floor, decaying wood, on shrubs and trees, rocks and along tracks.
Scrubland below forest.

MILKE BHANJYANG. 27° 19′ N., 87° 31′ E. Alt. 9,300–13,000 ft. 4.xii.61, 29.xii.61.
Rhododendron forest : forest floor, rocks, on trees and along tracks.
Downland above timber line : along tracks.

DOBHAN. 27° 22′ N., 87° 37′ E. Alt. 2,500 ft. 28.i.62–3.ii.62.
Low plateau between Tamur Khola and Maewa Khola : wooded cliffs at river junction and along East bank of Maewa Khola.
East bank of Tamur Khola : sheltered slopes, damp cliffs and gullies.

MEWA KHOLA GORGE CAMP AREA. 27° 33′ N., 87° 36′ E. Alt. 8,000–9,000 ft. 22.i.62–26.i.62.
Dense mixed evergreen forest : forest floor, rocks, walls, on trees and along tracks.
Base of 1,000 ft. rock cliff : numerous habitats.
West low cliff near river.
Smaller collection from various habitats along the route from Dobhan to the Mewa Khola camp, 20.i.62–21.i.62 and 27.i.62–28.i.62.

DHARAN. 26° 49′ N., 87° 16′ E. Alt. c. 1,000 ft. 26.ii.62–27.ii.62.
Sal forest : on trees and in ditches.

TUMLINGTAR. 27° 18′ N., 87° 13′ E. Alt. 1,800 ft. 7.xii.61–26.xii.61.
Plateau : ponds, bamboo groves and isolated trees.
East bank of Sabhaya Khola : wooded cliffs and gullies.
West bank of Sabhaya Khola : wooded cliffs, rocks, gullies and sandy shore.
South bank of Hinwan Khola : cliffs and along Chainpur track.
East bank of Arun Khola : wooded cliffs and gullies.

CHAINPUR. 27° 17′ N., 87° 19′ E. Alt. c. 4,000 ft. 6.xii.61, 7.xii.61–28.xii.61.
Isolated trees and along tracks.

ENTOMOLOGY

Over 21,000 insects were collected and although special attention was paid to the Diptera a wide range of material belonging to other orders, including representatives of the Orthoptera, Dermaptera, Ephemeroptera, Odonata, Neuroptera, Anoplura, Trichoptera, Hemiptera, Isoptera, Lepidoptera, Coleoptera and Hymenoptera, was obtained. With exception of the Odonata, which were particularly abundant over the paddy fields until late October the population of winged insects was not high. The field work began in late September and ended in early February and during this period most of the plants were in seed and failed to attract insects. Moreover, cold winds and frequent frost had by late November resulted in a further reduction of the population in exposed places. These circumstances stimulated a thorough exploration of the deeper ravines and other sheltered localities and an unusually extensive range of small Diptera was collected. Much of this material was collected by sweeping the dense vegetation bordering streams in deep gullies. Had the Expedition been in the field during the flowering season the time would have been almost fully spent in pursuit of the larger flies visiting the blooms and less attention would have been paid to the unexpectedly rich microfauna of the ravines.

Although a systematic study of the material has not yet been made a preliminary examination has revealed interesting affinities with the fauna of the mountainous regions of Burma, Indo-China and Northern Thailand. In localities up to an altitude of about 9,000 ft. palaearctic species were generally few and mostly those with a cosmopolitan distribution. An interesting exception were the copropnagous Sphaeroceridae (Borboridae) which were represented by palaearctic species even at altitudes as low as 1,000 ft.

LOCALITIES

SANGHU BASE CAMP AREA. 27° 21′ N., 87° 33′E. Alt. 5,500–7,000 ft. 2.x.61–4.xii.61, 1.i.62–16.i.62, 11.ii.62–19.ii.62.

Traps containing fermenting bananas and pears.
Fermenting fruits of the Bhor Tree (*Ficus religiosa*) on camp site.
Deep river gorge on Tamrang track : banks and mixed vegetation, dry and spray-splashed rocks.
Standing rice crops and rice stubble.
Herbaceous plants and flowering shrubs along tracks and in gullies.
Shallow ravine below camp site : splashed rocks and banks of stream.
Castanopsis forest : amongst trees and in clearings.
Scrubland above *Castanopsis* forest : amongst *Lycopodium* sp. and shrubs.
Blossoms of *Prunus* sp.
Caked mud in dried pools.
Gully torrents by Tembe track : banks, rocks and amongst overhanging trees.
Small wood immediately above camp.

SANGHU OAK FOREST AREA. 27° 19′ N., 87° 32′ E. Alt. c. 7,800–9,300 ft. 2.xi.61, 26.xi.61, 23.xi.61–4.xii.61, 11.i.62–14.i.62.

Forest, mainly *Quercus lamellosa* and *Q. lineata* : amongst trees in clearings and along tracks.
Scrubland below forest amongst *Lycopodium* sp.

CHAINPUR. 27° 17′ N., 87° 19′ E. Alt. c. 4,000 ft. 6.xii.61.
Around *Ficus religiosa* and on grassy plateau.

TUMLINGTAR. 27° 18′ N., 87° 13′ E. Alt. 1,800 ft. 8.xii.61–25.xii.61.
Traps containing fermenting banana at camp site.
Sandy West shore of Sabhaya Khola : pile of fermenting millet grain, leaves, human excrement and amongst evergreen shrubs.
West bank of Sabhaya Khola : grassy and rock slopes.
Plateau : bare sandy ground and flowering crop of *Guizotia abyssinica*.
East shore of Arun Khola, west of Tumlingtar : dwarf bamboo and evergreen shrubs in ravine, dried up streams and rock strewn mud flats.

DOBHAN. 27° 22′ N., 87° 37′ E. Alt. 2,500 ft. 23.i.62—3.ii.62.
East bank of Tamur Khola : ferns, mixed vegetation and amongst overhanging trees in deep ravine ; mixed vegetation on sheltered slopes.
East bank of Maewa Khola : rice stubble, arid slopes and sheltered slopes with mixed vegetation.
Tamur Khola : spray-splashed rocks.
Level plateau between junction of Tamur Khola and Maewa Khola : flowering shrubs, grasses and mixed vegetation.

ZOOLOGY

Although the zoological programme was concerned primarily with the Micro-arthropoda and Nematoda of soil and forest litter some general collecting was also undertaken and approximately 500 spiders and harvestmen, 800 mites (parasitic and free-living), 30 " other " arthropods, 392 fish, 37 amphibia, 48 reptiles, and 32 mammals were taken. Free living nematodes were collected by the Baermann technique in which small muslin bags of soil are immersed in water held in a glass funnel. The animals move out of the soil into the surrounding water and eventually accumulate in the funnel stem. Soil samples were also taken from arable land and dried for subsequent examination for cyst-forming plant-parasitic species. In addition some helminth parasites of vertebrates were collected.

Much has been written on extraction techniques for the investigation of soil and litter Micro-arthropoda (e.g. Macfadyen 1953) but for the fauna of organic soils and forest litter the only practical device for expedition purposes is some form of desiccation funnel. In this type of apparatus which was originally devised by Berlese (1905), the soil or litter is suspended on a sieve over a funnel and as the material dries the animals move downwards and eventually drop into a tube of preservative. Many recent modifications incorporate certain refinements which are important for quantitative work but almost all of these are unsuitable for expedition purposes as they either require elaborate laboratory facilities or utilise samples too small to yield sufficient material for systematic studies.

Although desiccation funnels have also been used with some success for studies of mineral soil populations there is considerable evidence that in such soils, and particularly in those containing a high proportion of particles belonging to the clay fraction, certain animals either do not respond to the stimulus of desiccation or perish before making their escape (Sheals 1957), and better results are often obtained with a flotation technique. A suitable apparatus is described by Raw (1955). Essentially the process consists of eliminating stones and large plant fragments by washing and sieving and then flooding the fine soil with a magnesium sulphate solution of specific gravity 1·12 in a flotation vessel known as the Ladell. The soil particles are dispersed in the solution by a stream of air led in from below, and, after settling, the animals and plant debris on the surface of the solution are collected by decanting on to a suitable sieve. A further separation of animals from plant debris is possible but this part of the process cannot be carried out without good laboratory facilities.

The bulk of the Micro-arthropoda was collected by means of a simple desiccation technique. Plastic funnels, 8½ in. in diameter, were used and the material under examination was carried on a circle of metal gauze 6¼ in. in diameter with a regular square mesh of 3 mm. Fifty-two funnels were set up on a bamboo framework in the Dharam Sala and a small battery of 8 funnels, used for the examination of dung, was accommodated in a canvas shelter. Paraffin pressure lamps were suspended over the indoor funnel assembly and the soil and litter samples were left on the funnels for at least 10 days. A series of mineral soil samples from grazed turf plots and rice terraces was examined by means of a flotation technique based substantially on the apparatus described by Raw (op. cit.) but modified for operation with limited facilities. The initial washing process was carried out with a 7-mesh sieve into plastic bowls, using jets of water from a hand-operated pump, and the soil was dispersed in the flotation vessel with a stream of air from a motor car foot pump. The finest sieve used had a regular square mesh of 152μ (100 mesh B.S.S.). No attempt was made to separate animals from the plant debris in the " float ", consequently many extracts are " dirty " and sorting is likely to be tedious. Nevertheless the use of flotation appears to have been justified, for a preliminary examination has revealed the presence of lightly sclerotized Acari, forms which are often difficult to obtain with desiccation methods.

In addition to obtaining material for systematic studies the micro-arthropod and nematode surveys were undertaken with a view to gathering ecological and zoogeographical data. In this connection it was felt that quantitative assessments would be useful and the numbers of individuals in the samples are being recorded. Population comparisons however will of necessity be made on a proportional basis for, owing to the difficulty of standardizing samples of the various soils and litter studied and the errors inherent in the extraction techniques, absolute numbers have little meaning. Many of the habitats studied were sampled repeatedly, not so much with a view to detailed phenological studies, but rather to obtain an adequate series of developmental instars and to obtain some replication for comparisons.

LOCALITIES

SANGHU BASE CAMP AREA. 27° 21′ N., 87° 33′ E. Alt. 5,500–7,000 ft. 2.x.61–4.xii.61, 1.i.62–16.i.62, 1.ii.62–17.iii.62.

Various habitats including mosses, soil and detritus on boulders, around trees and in small gullies.

Standing rice crops and walls of terraces.

Rice stubble ; soil and litter.

Cattle dung.

Ficus religiosa : tree-hole debris and soil round roots.

Surface and deeper soil of grazed turf plots (examined for micro-arthropods by both flotation and desiccation-funnels techniques).

Castanopsis forest : tree trunks, bark, leaf litter, surface and deeper soil, decaying wood and mosses.

Scrubland above *Castanopsis* forest : soil and litter.

Small wood immediately above camp-site.

Deep river gorge on Tamrang track : soil, litter, plant root systems, soil round roots of ferns and clinging to rocky cliffs.

SANGHU OAK FOREST AREA. 27° 19′ N., 87° 32′ E. Alt. 7,800—9,300 ft. 16.x.61, 26.x.61, 17.i.62.

Dense evergreen oak forest (*Quercus lamellosa* and *Q. lineata* dominating) : litter, surface and deeper soil, bark, mosses, liverworts and lichens on boulders and trees, decaying wood, tree-hole debris.

Forest clearing : soil of grazed mossy turf and moss alone.

MILKE BHANJYANG. 27° 19′ N., 87° 31′ E. Alt. 9,300–13,000 ft. 12.x.61, 17.xi.61, 22.xi.61–24.xi.61, 2.xii.61, 14.i.62 ; 17.i.62, 28.ii.62.

Rhododendron forest : litter ; surface and deeper soil ; mosses, liverworts and lichens on trees and boulders ; decaying wood.

Alpine turf above forest : soil examined to a depth of 9 in. with both flotation and desiccation funnel techniques for micro-arthropods and replicates examined for nematodes in two sub-samples, surface—5 in. and 5 in.–9 in. Mosses, lichens and liverworts in same general area, on stones and boulders.

Top of Milke Danra North of Milke Bhanjyang : grass and soil, surface soil round roots of rhododendrons, surface litter, moss, hard frozen soil (for nematodes only).

TOPKE GOLA. 27° 3′ N., 87° 35′ E. Alt. 12,500–13,000 ft. 27.x.61–28.x.61.

Small coniferous forest : litter, soil, tree-hole debris.

Rhododendron forest : litter, soil, decaying wood, mosses and organic soil on large boulder, tree-hole debris.

Juniper scrub (*Juniperus* (?)*squamata*) : litter and soil.

Alpine turf : surface soil.

SURKENAGI. 27° 14′ N., 87° 50′ E. Alt. c. 8,000 ft. 10.xi.61.

Rhododendron/Oak forest : litter, surface soil, deeper soil, tree-hole debris, soil of turf in clearing.

MEMENG. 27° 12′ N., 87° 56′ E. Alt. c. 5,000 ft. 11.xi.61.
Organic soil in rock crevices and soil of riverside turf.

SOLE. 27° 10′ N., 87° 56′ E. Alt. c. 8,000 ft. 12.xi.61.
Evergreen oak forest : litter, surface soil, tree-hole debris.

SANDAKPHU. 27° 06′ N., 88° 01′ E. Alt. 12,000 ft. 13.xi.61.
Rhododendron/conifer scrub : surface soil.
Dwarf *Rhododendron* copse : surface soil.

DHARAN. 26° 49′ N., 87° 16′ E. Alt. c. 1,000 ft. 21.xi.61, 27.ii.62.
Sal forest : surface soil, decaying wood, moss on bank of stream.
Rice stubble : surface soil.

PHUSRE. 26° 50′ N., 87° 17′ E. Alt. c. 3,000 ft. 22.xi.61.
Moss on dry bank, litter in scrubland on side of track.

MULNGHAT. 26° 56′ N., 87° 19′ E. Alt. c. 1,000 ft. 23.xi.61.
Grazed turf : surface soil.
Moss and litter under bushes near stream bed.

POPTI LA ROUTE. 27° 47′ N., 87° 21′ E. Alt. 10,800 ft. 21.xii.61.
Rhododendron/Conifer forest : litter, soil, mosses on trees and boulders, decaying wood, tree-hole debris.
Cardocrinum giganteum : soil around roots.
Evergreen Oak forest : litter, soil and decaying wood.

NUM. 27° 33′ N., 87° 18′ E. Alt. c. 5,000 ft. 15.xii.61.
Rice stubble : surface soil.
Grazed turf : surface and deeper soil.
Castanopsis forest : litter and surface soil.

DHOJE. 27° 26′ N., 87° 13′ E. Alt. c. 6,500 ft. 15.xii.61.
Grazed turf : surface soil.
Ungrazed grassland : surface soil.

DHANRGAON. 27° 28′ N., 87° 15′ E. Alt. c. 7,000 ft. 15.xii.61.
Mixed woodland, mainly oak : litter.
Mosses and soil on old stone walls.

TUMLINGTAR. 27° 18′ N., 87° 13′ E. Alt. c. 1,800 ft. 21.xii.61–25.xii.61.
Immediate area of camp site : rotting banana on ground, grass roots and soil, soil round bamboo, moss, rotting wood.
Hinwan Khola : damp grazed turf surface soil, soil from beneath rotting maize straw and straw itself.
Sabhaya Khola : shallow dammed lagoon with fish trap and very heavy growth of algae, boulders along edge of river.

DOBHAN. 27° 22′ N., 87° 37′ E. Alt. 2,500 ft. 25.i.62–1.ii.62.
Taplejung bank of Tamur Khola : damp, muddy soil, from grassy area and also under trees ; bottom litter and soil in small wood ; mosses.
Plateau between junction of Tamur and Maewa Kholas : surface soil and grass roots, surface litter beneath and soil from around roots of scattered bushes.

Tamur Khola about 1–2 hours march South of Dobhan : forest bottom litter, turf and mosses.

ANBUNG. 27° 16′ N., 87° 42′ E. Alt. c. 2,500–3,000 ft. 31.i.62–2.ii.62.
Pinus roxburghii woodland : litter.
Deep gully : plant debris and soil.
Mixed woodland, mainly *Castanopsis* : litter and soil.
Ridge above Hangpang, Alt. c. 6,000 ft. : Scrubland, mainly *Pinus roxburghii* : litter and soil.
Junction of Tamur and Kabeli Kholas : forest bottom litter, soil and mosses.

HATIA. 27° 44′ N., 87° 21′ E. Alt. c. 7,500 ft. 23.xii.61.
Evergreen Oak forest : litter and surface soil.

WALUNGCHUNG GOLA. 27° 41′ N., 87° 47′ E. Alt. c. 12,700 ft. 2.ii.62.
Rhododendron/conifer forest : litter, soil, moss on rocks.
Coniferous forest : bottom litter.

SELAP. 27° 38′ N., 87° 49′ E. Alt. 10,000–10,300 ft. 4.ii.62.
Rhododendron forest : litter, and moss on rocks.
Rhododendron/*Berberis* scrub : litter.

LUNGTHUNG. 27° 33′ N., 87° 48′ E. Alt. c. 6,400 ft. 5.ii.62.
Rice stubble : surface soil.

HELLOK. 27° 31′ N., 87° 48′ E. Alt. 6,100 ft. 5.ii.62.
Mixed forest, mainly oak : litter and surface soil.

DHANKUTA. 26° 59′ N., 87° 21′ E. Alt. c. 4,000 ft. 3.iii.62.
Coniferous forest : litter.

HILE. 27° 01′ N., 87° 19′ E. Alt. c. 6,000 ft. 3.iii.62.
Soil from cultivated terrace, no plant cover.
Grazed damp turf : surface soil.

CHITRE. 27° 07′ N., 87° 24′ E. Alt. c. 7,000 ft. 4.iii.62.
Mixed forest, mainly oak : surface litter.

PERSONNEL

J. G. Sheals, zoologist, leader first phase ; W. G. Inglis, zoologist, leader second phase ; R. L. Coe, entomologist, deputy leader ; A. H. Norkett, botanist, K. H. Hyatt, zoologist ; T. Le M. Spring Smyth, administrative officer ; and B. P. Sharma, liaison officer.

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PLATE 1

The Expedition Base Camp at Sanghu. The rest house (left) facing the tents was equipped as a laboratory-cum-messroom.

PLATE 2

Sanghu Base Camp. Part of the battery of " outdoor " funnels used for the extraction of arthropods from dung, etc.

PLATE 3

Sanghu Base Camp. Flotation extraction : decanting the " float " on to a 100 mesh sieve.

PLATE 4

The Tamur River below Dobhan, looking North.

PLATE 5

Maewa Khola : evergreen oak forest above Sanghu Base Camp.

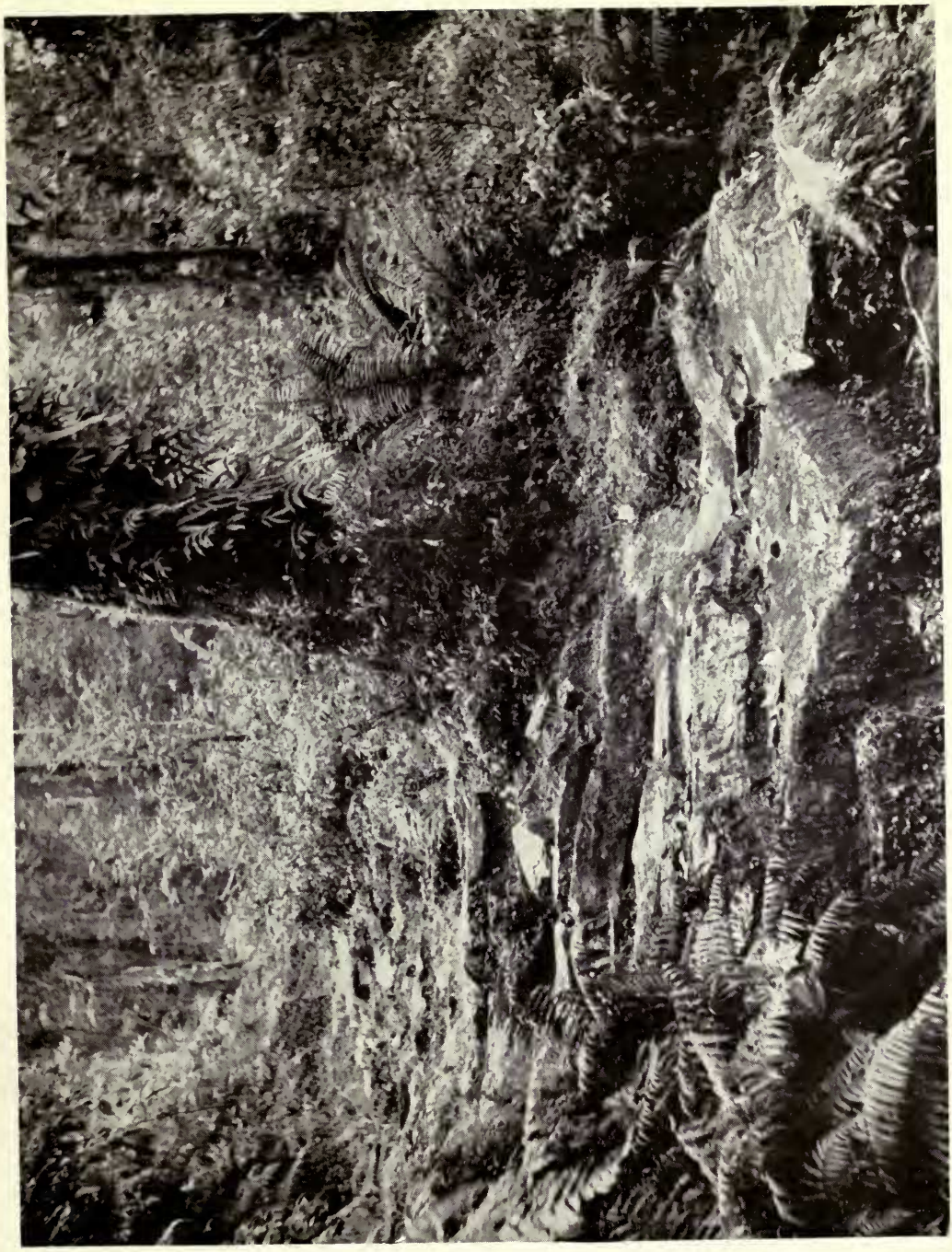

PLATE 6

Milke Danra : downland and rhododendron forests.